MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

EEE 7286 – ENERGY MANAGEMENT IN INDUSTRY

01 MARCH 2019
9:00 AM – 12:00 AM
(3 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages including cover page with 4 Questions only.
2. Answer ALL questions. The distributions of the marks for each question are as stated.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) (i) Describe any three different forms of energy.

[6 marks]

(ii) Distinguish between renewable energy and non-renewable energy. State two examples of resources for each type of energy.

[6 marks]

(b) A new office space to be used as a drawing office is to be illuminated. The dimension of the office is 12 m (length) x 10 m (width) x 3 m (height). Choices of LED downlights and their specification are given below.

LED-1
13W, 1000lm, 3000K

LED-2
100 lm/W, 16W, 3000K

a) Determine the minimum illuminance for this office space. Refer to table in Appendix A.

[2 Marks]

b) Determine the number of lamps required to obtain the minimum illuminance and highest efficacy. Assuming the maintenance factor is 0.8 and that coefficient of utilization is 0.6. The maximum lighting power intensity allowed is 14 W/m^2 and maximum colour temperature is 3500K.

[7 Marks]

c) List down two advantages and disadvantages of LED lamps.

[4 Marks]

Continued...

Question 2

(a) Explain the Affinity laws with suitable graphs and how the law can be used to save energy in an exhaust fan system.

[10 marks]

(b) Table Q2a and Q2b show the details of 15 blowers and fans in a factory. Explain clearly on how you can help the factory to save on energy for these 15 blowers system.

[7 marks]

Table Q2a : Rated values and basic Information

No	MACHINES (BLOWER)	Section	Years of operation (Years)	Running Time (Hours)	Poles	Starter	Efficiency Class	Damper Control (fully/2/3 level)	Rated Values					
									P_M (kW)	HP (hp)	V (V)	I(A)	RPM	Eff
1	NF1-Blower 1st Stage	NF1 (TG 1)	33	20	4	Auto Trans	IE1	3	370		3300	80	1480	0.86
2	NF1-Blower 2nd Stage	NF1 (TG 1)	18	20	4	Auto Trans	IE1	3	400		3300	86	1485	0.86
3	NF1- Cooling Fan	NF1 (TG 1)	33	20	4	Auto Trans	IE1	Fully	75	100	415	132	1470	0.86
4	NF2- Inlet Vane Upper	NF2 (TG 1)	22	20	4	Soft Starter	IE1	2	260	350	415	439	1485	0.86
5	NF2- Inlet Vane Lower	NF2 (TG 1)	22	20	4	Soft Starter	IE1	3	260	350	415	447	1495	0.86
6	NF2- Blower 2nd Stage Lower	NF2 (TG 1)	22	20	4	Auto Trans	IE1	3	260	350	415	447	1485	0.86
7	NF2- Blower 2nd Stage Upper	NF2 (TG 1)	22	20	4	Soft Starter	IE1	2	260	350	415	447	1485	0.86
8	NF2- Cooling Fan Lower	NF2 (TG 1)	22	20	4	Auto Trans	IE1	Fully	55	75	415	93.9	1475	0.86
9	NF2- Cooling Fan Upper	NF2 (TG 1)	22	20	4	Auto Trans	IE1	Fully	55	75	415	98.7	1475	0.86
10	NF3- Blower 1st Stage Lower	NF3 (TG 1)	10	20	4	Soft Starter	IE1	3	260	350	415	440	1485	0.86
11	NF3- Blower 1st Stage Upper	NF3 (TG 1)	10	20	4	Soft Starter	IE1	2	260	350	415	439	1485	0.86
12	NF3- Blower 2nd Stage Lower	NF3 (TG 1)	10	20	4	Soft Starter	IE1	3	260	350	415	440	1485	0.86
13	NF3- Blower 2nd Stage Upper	NF3 (TG 1)	10	20	4	Soft Starter	IE1	2	260	350	415	439	1485	0.86
14	NF3- Cooling Fan Lower	NF3 (TG 1)	20	20	4	Auto Trans	IE1	Fully	55	75	415	98.9	1475	0.86
15	NF3- Cooling Fan Upper	NF3 (TG 1)	20	20	4	Auto Trans	IE1	Fully	55	75	415	98.9	1475	0.86

Table Q2b : Measured Values

No	MACHINES (BLOWER)	Rated Values		Measured Values						Loading Factor
		P_M (kW)	Eff	P_E (kW) - Max.	P_E (kW) - Average	V (V)	I(A)	RPM	pf	%
1	NF1-Blower 1st Stage	370	0.86	235.5	129.2	3300	52.2	1486	0.75	54.7
2	NF1-Blower 2nd Stage	400	0.86	257.4	202.9	3300	75	1489	0.82	55.3
3	NF1- Cooling Fan	75	0.86	46.7	46.7	408	95	1489	0.72	53.8
4	NF2- Inlet Vane Upper	260	0.86	200	153	241	330	1490	0.82	66.2
5	NF2- Inlet Vane Lower	260	0.86	230	171.2	240	410	1489	0.8	76.1
6	NF2- Blower 2nd Stage Lower	260	0.86	230	196.75	416	360	1487	0.8	76.1
7	NF2- Blower 2nd Stage Upper	260	0.86	220	132	417	370	1491	0.84	72.8
8	NF2- Cooling Fan Lower	55	0.86	33.4	33.4	414	68.5	1489	0.69	52.2
9	NF2- Cooling Fan Upper	55	0.86	30.8	30.8	240	66	1490	0.66	48.2
10	NF3- Blower 1st Stage Lower	260	0.86	230	191	413	430	1490	0.86	76.1
11	NF3- Blower 1st Stage Upper	260	0.86	175	155.9	415	242	1495	0.71	57.9
12	NF3- Blower 2nd Stage Lower	260	0.86	256	202	235	372	1488	0.8	84.7
13	NF3- Blower 2nd Stage Upper	260	0.86	210	150.6	243.5	410	1490	0.71	69.5
14	NF3- Cooling Fan Lower	55	0.86	31.9	31.9	243	65	1486	0.7	49.9
15	NF3- Cooling Fan Upper	55	0.86	43.9	43.9	243	81.3	1488	0.77	68.6

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(c) Explain two ways to improve efficiency of motor for each of the following applications.

(i) A conveyor connected to a gear box running at constant speed for 18 hrs/day.
[4 marks]

(ii) A pump running at a constant speed of 16 hrs/day. Flow is controlled using a throttle.
[4 marks]

Continued...

Question 3

(a) Based on the information found in the electricity bill (shown in Table Q3. The factory is currently drawing power from Tenaga Nasional Berhad under the E2 Industrial Tariff. Details of the tariff are given below.

For peak usage per month	35.50 cents/kWh
For off- peak usage per month	21.90 cents/kWh
For maximum demand recorded per month	RM 37.00/kW

Table Q3

Month	Maximum Demand (kW)	Off Peak (kWh)	Peak (kWh)
Jul-15	568	121,239	194,415
Aug-15	568	115,541	196,922
Sep-15	574	111,720	196,476
Oct-15	557	115,598	195,080
Nov-15	555	113,980	189,752
Dec-15	546	120,341	187,080

i. State and explain type of tariff structures for E2 Industrial Tariff.

[3 marks]

ii. Calculate the total energy cost for the factory for the six months (July 2015 to December 2015).

[6 marks]

iii. Calculate the load factor if the factory operates 30 days in a month (Peak hours are from 8 AM to 10 PM and off-peak hours are from 10 PM to 8 AM).

[6 marks]

iv. Explain three ways to minimize high maximum demand charge.

[3 marks]

(b) The capital cost of a power generating equipment in a power plant is RM 180 million. The useful life of the equipment is 20 years and its salvage value is 6.0 % of its total cost. Determine the amount of money to be deposited annually for replacement by sinking-fund method. Assume that the annual compound interest is 5.0 %.

[7 marks]

Continued...

Question 4

(a) Thermal insulation plays an important role in improving the thermal efficiency of buildings. State any two types of insulation and insulation materials commonly used in a building.

[8 marks]

(b) What is a captive power plant? Discuss the need for a captive power plant in an industry.

[8 marks]

(c) A captive power plant (CPP) located in an industry is operating in parallel with the grid. It is desirable to import power from the grid at unity power factor. A capacitor bank is connected at the 11 kV bus of the CPP bus to adjust the power factor. Calculate the real and reactive powers to be imported from the grid and the value of capacitor connected at the 11 kV bus.

Following are the details of the system.

- The total power requirement of the industry is 60 MW at 0.85 power factor lagging.
- Total real and reactive power losses in the distribution system of the industry are 3 MW and 2 MVAR, respectively.
- The real and reactive powers generated by the captive generator are 25 MW and 15 MVAR, respectively.

[9 marks]

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Appendix A

Table 10. Recommended average illuminance levels

Task and Applications	Illuminance (Lux)	Minimum CRI
a) Lighting for infrequently used area:		
- Minimum service illuminance	20	30
- Interior walkway and car-park	100	40
- Hotel bedroom	100	60
- Lift interior	100	40
- Corridor, passageways, stairs	100	40
- Escalator, travellator	150	40
- Entrance and exit	100	60
- Staff changing room, locker and cleaner room, cloak room, lavatories, stores.	100	60
- Entrance hall, lobbies, waiting room	100	60
- Inquiry desk	300	80
- Gate house	200	80
b) Lighting for working interiors		
- Infrequent reading and writing	200	80
- General offices, shops and stores, reading and writing	300 - 400	80
- Drawing office	300 - 400	85
- Restroom	150	80
- Restaurant, canteen, cafeteria	200	80
- Kitchen	150 - 300	80
- Lounge	150	60
- Bathroom	150	80
- Toilet	100	60
- Bedroom	100	80
- Class room, library	300 - 500	80
- Shop/supermarket/department store	200 - 750	80
- Museum and gallery	300	80
c) Localised lighting for exacting task		
- Proof reading	500	80
- Exacting drawing	1000	80
- Detailed and precise work	2000	80

End of Paper